CLAIMS

I claim:

1: An MIMO (multiple-input multiple-output) PID controller which has

- an n-dimensional process variable vector PV with the n process variables PV1, PV2, ..., and PVn being its first, second, ..., and n-th component,
- an n-dimensional set point vector SP with the n set points SP1, SP2, ..., and SPn being its first, second, ..., and n-th component, and
- an m-dimensional controller output vector CO with the m controller outputs CO1, CO2, ..., and COm being its first, second, ..., and m-th component,

where m and n are positive integers, and in which the PID control equation is CO(k) = CO(k-1) + K1*SP(k)*T + K1*a(k,1) + K2*a(k,2) + ... + Kj*a(k,j), where k is the discrete time, T is the sampling period, j is a positive integer, K1, K2, ..., Kj are m by n PID parameters, a(k,1) = [-PV(k)]*T, and a(k,j) = [a(k,j-1) – a(k-1,j-1)]/T for j > or = 2.

2: An MIMO PID controller of Claim 1, in which the m by n PID parameters K1, K2, ..., and Kj are obtained by using an optimization algorithm which minimizes the largest modulus of all poles of the discrete time closed loop transfer function from said SP to said PV.

3: An MIMO PID controller of Claim 2, wherein the said optimization algorithm is a constrained optimization algorithm which minimizes the largest modulus of all poles of the discrete time closed loop transfer function from said SP to said PV and at the same time guarantees that the user prescribed constraints on the PID parameters are satisfied.

4: An MIMO PID controller of Claim 1, wherein some or all of the terms K2*a(k,2), K3*a(k,3), ..., and Kj*a(k,j) that appear on the right-hand side of the PID control

equation are removed, for example, a PID controller with its control equation being CO(k) = CO(k-1) + K1*SP(k)*T + K1*a(k,1) = CO(k-1) + K1*[SP(k)-PV(k)]*T, which is also called a I-only controller, and a PID controller with its control equation being CO(k) = CO(k-1) + K1*SP(k)*T + K1*a(k,1) + K2*a(k,2) = CO(k-1) + K1*[SP(k)-PV(k)]*T - K2*[PV(k)-PV(k-1)], which is also called a PI controller, etc.

5: An MIMO PID controller of Claim 4, wherein the remaining PID parameters are obtained by using an optimization algorithm which minimizes the largest modulus of all poles of the discrete time closed loop transfer function from said SP to said PV.

6: An MIMO PID controller of Claim 5, wherein the said optimization algorithm is a constrained optimization algorithm which minimizes the largest modulus of all poles of the discrete time closed loop transfer function from said SP to said PV and at the same time guarantees that the user prescribed constraints on the PID parameters are satisfied.

7: A PID controller of Claim 1, wherein said PV, said SP, said CO, and said PID parameters are all scalars, and m=n=1.

8: A PID controller of Claim 2, wherein said PV, said SP, said CO, and said PID parameters are all scalars, and m=n=1.

9: A PID controller of Claim 3, wherein said PV, said SP, said CO, and said PID parameters are all scalars, and m=n=1.

10: A PID controller of Claim 4, wherein said PV, said SP, said CO, and said PID parameters are all scalars, and m=n=1.

11: A PID controller of Claim 5, wherein said PV, said SP, said CO, and said PID parameters are all scalars, and m=n=1.

12: A PID controller of Claim 6, wherein said PV, said SP, said CO, and said PID parameters are all scalars, and m=n=1.

13: A method of finding the optimal PID parameters for any traditional independent or dependent form of PID controllers by using a qualified minimax algorithm that minimizes the largest modulus of all poles of the discrete time closed loop transfer function from set point SP to process variable PV.

14: A method of Claim 13, wherein the minimax algorithm is a constrained minimax algorithm which minimizes the largest modulus of the discrete time closed loop transfer function from said SP to said PV and at the same time guarantees that all PID parameters are within their admissible ranges.